MINI FAN

INVENTORS: Wolfgang Arno WINKLER & Nils RAPP

CROSS-REFERENCE: This application is a section 371 of PCT/EP2004/005017, filed 11 MAY 2004, claiming priority from German applications DE 203 11 207, filed 16 JUL. 2003 and DE 20 2004 005 341, filed 30 MAR. 2004, the disclosures of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The invention relates to a mini-fan. Such fans are also referred to as miniature or subminiature fans.

BACKGROUND

Mini-fans serve, for example, to cool processors in computers, for the cooling of small equipment items, etc. and have very small dimensions. For example:

- fans of the ebm-papst 250 series have dimensions of 8 x 25 x 25 mm;
- those of the ebm-papst 400F series, dimensions of 10 x 40 x 40 mm;
- those of the ebm-papst 400 series, 20 x 40 x 40 mm; and
- those of the ebm-papst 600 series, 25 x 60 x 60 mm.

The power consumption of such fans is 0.4-0.6W for the 250 series, 0.7-0.9 W for the 400F series, and 0.9-3.4 W for the 400 and 600 series. The weight is, for example, approximately 5 (five) grams for the 250 series, between 17 and 27 g for the 400/400F series, and approximately 85 g for the 600 series.

With fans of this miniature size, which must be very inexpensive, it is important to make assembly as simple as possible in order to enable a high level of automation during manufacture. Only extensive production automation additionally makes possible uniform quality in such fans, which is a prerequisite for a long average service life.

A complicating factor with such mini-fans is furthermore that their components, entirely comparable to those of a mechanical watch mechanism, are very delicate and therefore not robust. The rotor shaft, for example, is often only as thick as a knitting needle, and can therefore easily be bent if handled carelessly, rendering the fan unusable. This danger exists in particular during the assembly of such a mini-fan, for example when it must be acted upon by a force for assembly purposes.

SUMMARY OF THE INVENTION

An object of the invention is therefore to make available a novel mini-fan. According to the invention, this object is achieved by configuring the fan motor with an internal stator and external rotor, the rotor being rotatably supported in a bearing tube equipped with a closure arrangement which closes off one end of the bearing tube in a liquid-tight manner, and includes at least one resilient securing member to engage into a necked down portion of the rotor shaft and thereby keep the rotor shaft from being pulled out of the bearing.

What is thereby achieved, with simple means, is a secure, liquid-tight join between the bearing tube and the closure arrangement. Because the invention makes it possible to assemble the internal stator while it is still separate from the rotor, and because the internal stator is a substantially more robust component than the external rotor, the danger of damage during the assembly operation is substantially reduced.
In the context of a mini-fan according to the present invention, it is therefore possible first to assemble the internal stator; and once the latter has been, for example, soldered in place on a circuit board, the rotor can then very easily be installed and at the same time secured, by way of the at least one resilient securing member, against being inadvertently pulled out.

Further details and advantageous refinements of the invention are evident from the exemplifying embodiments, in no way to be understood as a limitation of the invention, that are described below and depicted in the drawings.

BRIEF FIGURE DESCRIPTION

FIG. 1 is a greatly enlarged longitudinal section through a mini-fan according to a preferred embodiment of the invention; for illustration only, a one-centimeter length is indicated for comparison, although the size of the fan can of course fall within the limits typical for such miniature and subminiature fans;

FIG. 2 is an even greater enlargement to explain the lubricant circulation in the bearing arrangement with plain bearing that is depicted;

FIG. 3 depicts one possible variant for connecting the stator winding of the external-rotor motor according to FIGS. 1 and 2 to a circuit board;

FIG. 4 is a very greatly enlarged longitudinal section through a mini-fan according a second embodiment of the invention;

FIG. 5 shows a portion of FIG. 4 at location V therein;

FIG. 6 is a section according to a first alternative, looking along line VI-VI of FIG. 4;

FIG. 7 is a section according to a second alternative, looking along line VI-VI of FIG. 4;

FIG. 8 is a section analogous to FIG. 4, but after the mating of the internal stator and circuit board;

FIG. 9 is a depiction analogous to FIG. 8, but before the mating of the internal stator and external rotor; and

FIG. 10 is a depiction analogous to FIG. 9, but after the mating of the internal stator and external rotor; the external rotor is secured on the internal stator against being pulled out, and the lower (in FIG. 10) side of the bearing support tube is closed off in liquid-tight fashion.

DETAILED DESCRIPTION

FIG. 1 shows, at very greatly enlarged scale, a longitudinal section through a mini-fan 16 associated with which, for driving thereof, is an external-rotor motor 20. Fan 16 can have, for example, dimensions of 10 x 30 x 30 mm. Motor 20 has an external rotor 22 having a rotor cup 24, preferably made of a thermally conductive plastic, on whose outer periphery fan blades 26 are provided. A magnetic yoke 27 made of soft iron is mounted in rotor cup 24, and on the yoke's inner side is a radially magnetized rotor magnet 28 that can be magnetized, for example, with four poles. The outside diameter of external rotor 22 can range, for example, from approximately 14 to approximately 35 mm.

Fan 16 is depicted here as an axial fan, but the invention is equally applicable, for example, to diagonal fans and to radial fans.

Rotor cup 24 has at its center a hub 30 in which is mounted, in thermally conductive fashion by plastic injection molding, a correspondingly shaped upper shaft end 32 of a rotor shaft 34 whose lower, free end is labeled 35.

Radial support of shaft 34 is provided by a plain bearing 36 that preferably is implemented as a sintered bearing. Alternatively in the context of the invention, in order to achieve a particularly long service life, shaft 34 can also be supported using rolling bearings. Plain bearing 36 is mounted by being pressed into the interior of a constriction 37 of a bearing tube 38. Bearing tube 38 is preferably manufactured from steel, brass, or another suitable metal, or if applicable also from a plastic. Provided at its lower end is a radial projection in the form of a flange 39, which serves for the mounting of fan 16 and here extends approximately perpendicular to rotation axis 41 of rotor 22. Internal stator 44 of motor 20 is mounted on the outer side of bearing tube 38 by being pressed on.

Constriction 37 has a substantially cylindrical inner side 40 (FIGS. 2 and 3) whose surface is particularly carefully machined, while the remainder of the inner side of bearing tube 38 needs to be only roughly machined. Corresponding to constriction 37, sintered bearing 36 has a bulging portion 42 having a diameter that corresponds approximately to the diameter of inner side 40 and is dimensioned so that a tight fit results upon assembly in inner side 40. Within portion 42, sintered bearing 36 has a portion 43 (FIG. 2) having an enlarged diameter, at which the sintered bearing does not make contact against shaft 34. This prevents sintered bearing 36 from being excessively radially compressed in the event of an accumulation of unfavorable tolerances, which might make it impossible to insert shaft 34.

A lower plain bearing portion 48 is located below portion 43, and an upper plain bearing portion 50 is located above portion 43 (cf. FIG. 2). It has been found that specifically in mini-fans with their small dimensions, very reliable support of shaft 34, and a correspondingly long service life for motor 20, are thereby obtained.